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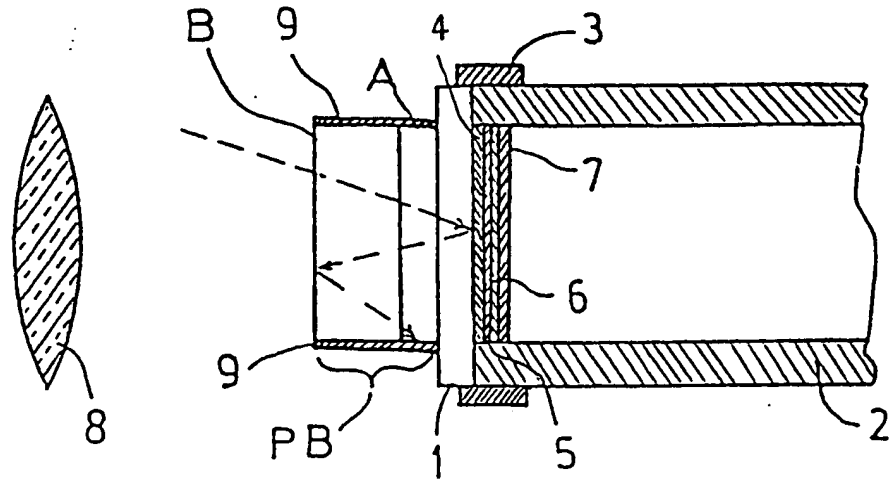
(71) Applicant
Nippon Victor Kabushiki Kaisha
(Japan)
3-12 Moriya-cho
Kanagawa-ku
Yokohama
Japan
(72) Inventors
Itsuo Takanashi
Shintaro Nakagaki
Kenichi Miyazaki
Hiroshi Ichimura
(74) Agent and/or Address for Service
Withers & Rogers
4 Dyers Buildings
Holborn
London EC1N 2JT

(54) Apparatus for generating colour television signals

(57) An image pickup device, for a colour TV camera has an optical block (PB) adhering to the front surface of a face plate of the device and which includes a near-infrared absorption filter (A) by which near-infrared light is removed from light applied through a lens system (8) so that undesirable phenomena such as flares and ghost images are effectively prevented. The optical block may include a crystal filter (B) attached to the near-infrared absorption filter and, further, the outer periphery of the optical block may be covered by a black body (9), which may be black material or paint applied thereto, for effective absorption of undesirable light.

FIG. 8



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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

FIG. 1

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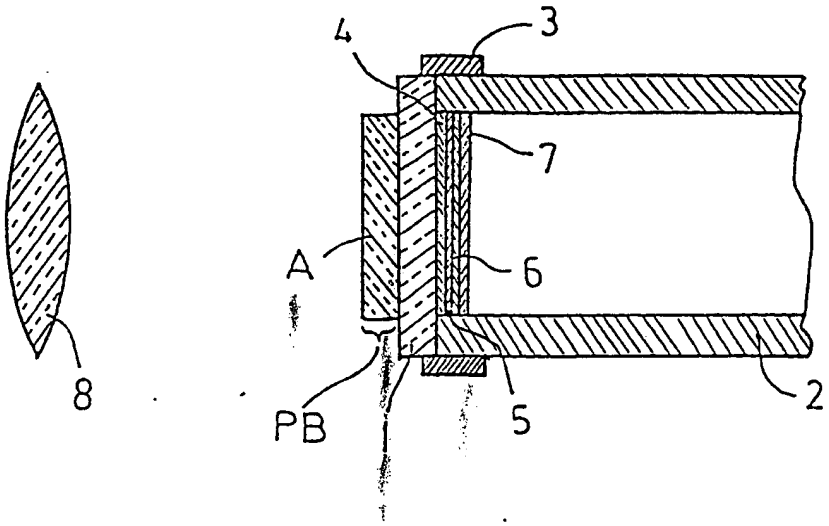

FIG. 2

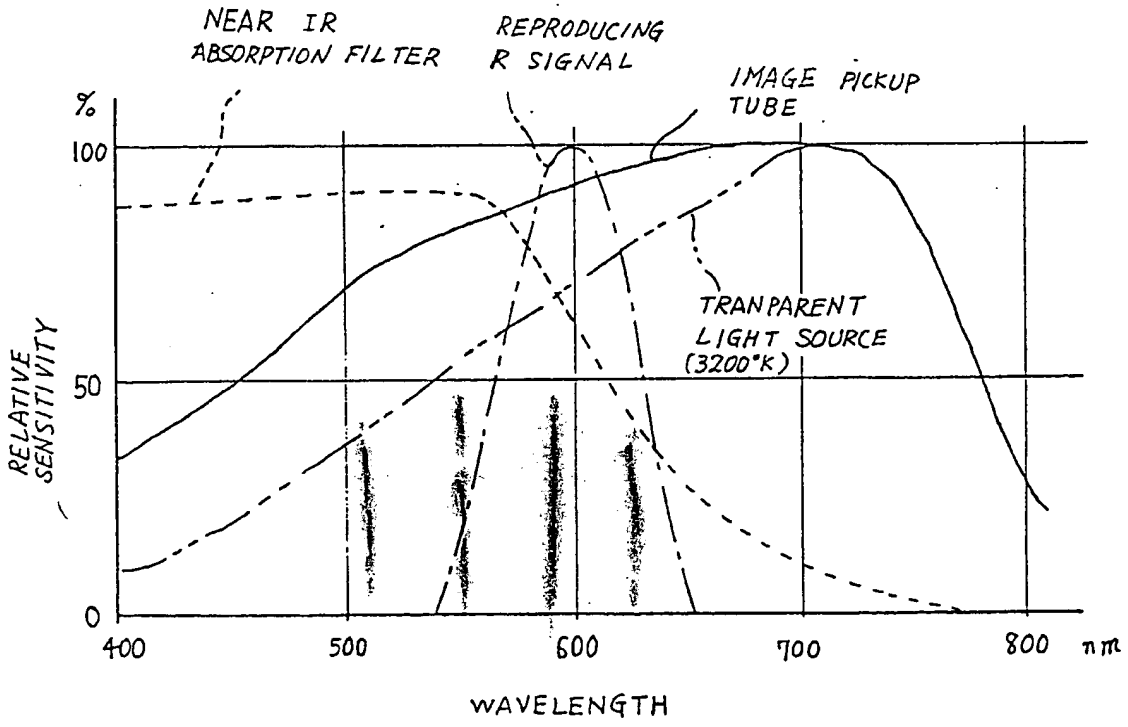

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FIG. 3

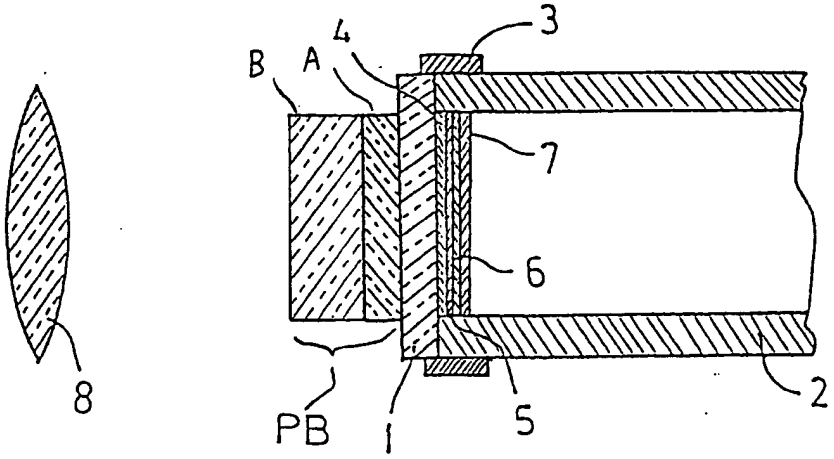

FIG. 4

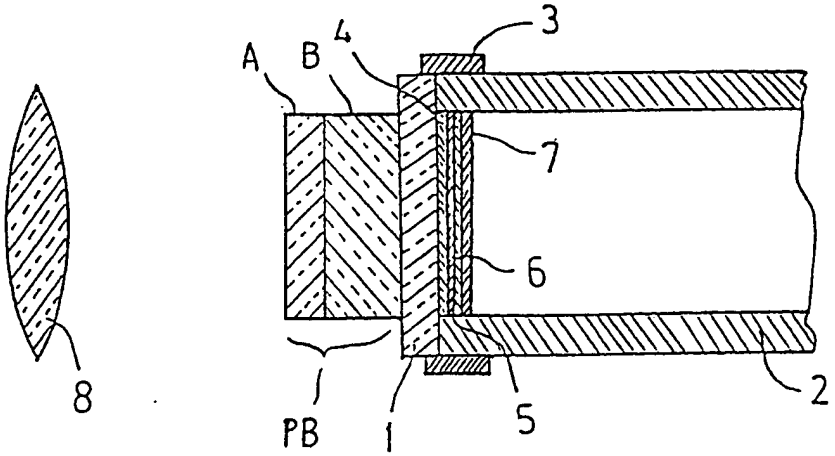

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FIG. 5

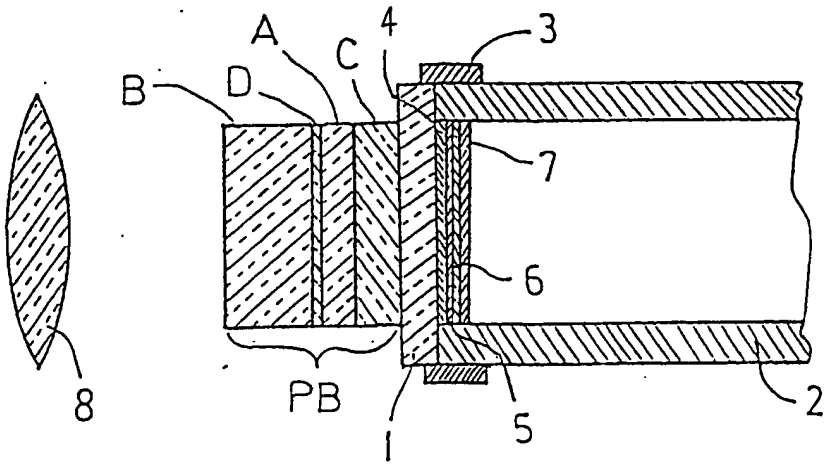

FIG. 6

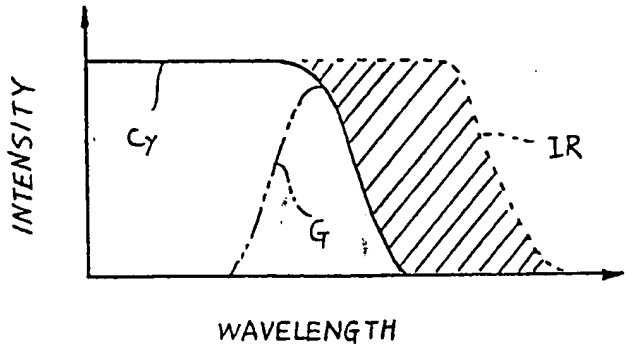

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FIG. 7

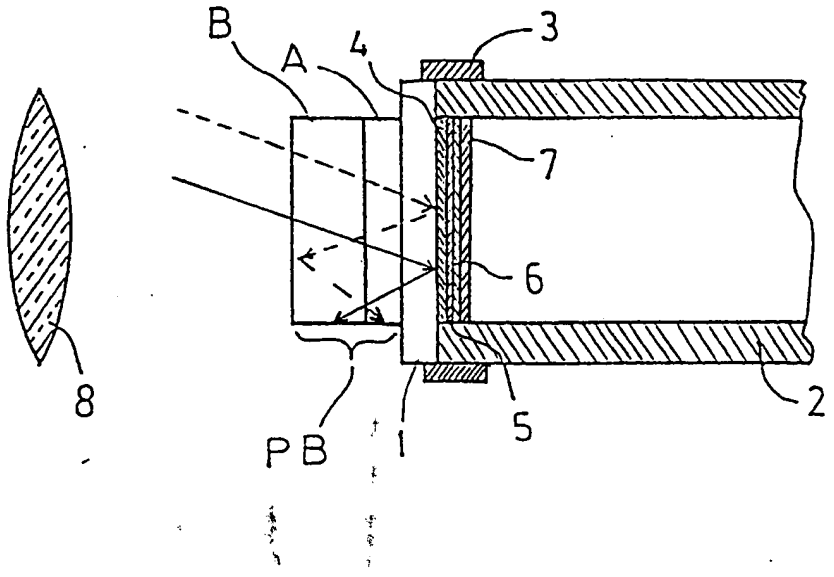
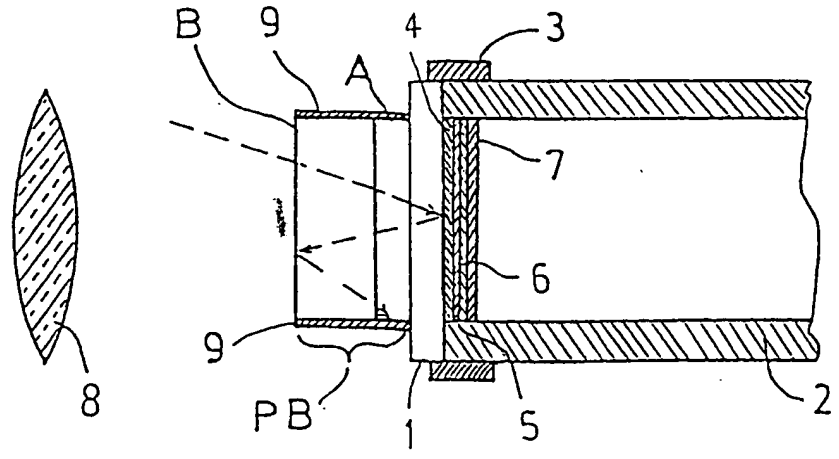


FIG. 8



SPECIFICATION

Apparatus for generating colour television signals

This invention relates to apparatus for generating colour television signals more particularly such apparatus for use in a colour television (TV) image pickup device such as a colour TV camera.

A colour TV image pickup device having on a transparent plate a photoelectric converting device including a colour-resolving filter which causes the image pickup device to generate a multi-colour video signal, are well known. The optical system thereof is simple and compact and light weight image pickup devices are readily available. One such image pickup device is single tube TV camera having an image pickup tube with an imaging device at a face plate thereof, and a colour resolving filter enabling the production of a multi-colour video signal. Another example is the single plate TV camera having a solid image sensor with a photoelectric converting device and a colour resolving filter for producing a multi-colour video signal.

Imaging devices for colour TV cameras, are required to generate a colour video signal which will reproduce high quality image or pictures on a cathode ray tube (CRT). When unnecessary reflection occurs within the optical system of such an imaging device, however, flares are apt to occur which result in low or poor quality reproduction. Various attempts have been made to avoid this drawback of conventional image pickup devices.

In image pickup devices having an inorganic colour resolving filter for separating incoming light into a plurality of colours so that a multi-colour video signal will be generated, (the light at wavelengths which cannot transmit therethrough being reflected by the filter), reflected light tends to be reflected several times within the transparent face plate, carrying the photoelectric converting device, or tends to be reflected at the taking lens of the optical system, before light is applied to the photoelectric converting device. As a result, flares and/or ghost images and undesirable phenomena occur. Such phenomena are especially noticeable when a subject such as a candle flame, emitting light including light at relatively long wavelengths, is received by a TV camera having an imaging device of the above-mentioned kind. This is partly because such long-wavelength light is repeatedly reflected without significant attenuation so that flares and ghosts appear around (e.g.) the candle flame, considerably detracting from the quality of reproduction.

One object of the present invention is to avoid the above-mentioned drawbacks by enabling suppression of undesirable multiple reflections of near-infrared light rays within the optical system of an image pickup device.

We now propose an optical block including a near-infrared absorption filter and adhered to a face plate of a photoelectric converter of the image pickup device so that light rays transmitted through a lens system is applied to the face plate after propagating through the optical block. Since the optical block is adhered to one surface of the face plate, some light reflected at a colour-resolving filter on the other surface of the face plate, is directed to the periphery of the optical block thereby reducing undesirable light.

According to this invention, apparatus for generating colour television signals comprises lens means; photoelectric converter having a transparent face plate, a colour-resolving striped filter, and a colour TV imager responsive to light applied thereto from the lens means via the face plate and the colour-resolving filter for producing a colour video signal; and an optical block having a near-infrared absorption filter, the optical block being disposed between the lens means and the face plate with one surface thereof adhered to a surface of the face plate.

Other features of the present invention are set forth in the appendant claims and in the following description of various embodiments of the present invention. In the description reference is made to the accompanying drawings in which:

Figure 1 is a schematic cross-sectional side view of a first embodiment of the present invention;

Figure 2 is a graph illustrating the optical characteristic of the near-infrared absorption filter used in the first embodiment;

Figure 3 is a schematic cross-sectional side view of a second embodiment of the present invention;

Figure 4 is a schematic cross-sectional side view of third embodiment of the present invention;

Figure 5 is a schematic cross-sectional side view of a fourth embodiment of the present invention;

Figure 6 is a diagram illustrating the operation of a colour TV image pickup device according to the invention;

Figure 7 is a diagram of the light path within the optical block shown in Fig. 2; and

Figure 8 is a schematic cross-sectional side view of a fifth embodiment of the present invention.

The same or corresponding elements and parts are designated by the same reference

numerals throughout the drawings.

Referring now to Fig. 1 the image pickup device of a colour TV camera of the kind having a single-tube imaging or pickup device, comprises a taking lens system, which is represented by a single lens 8, and an image pickup tube including a transparent face plate 1, a cylindrical tube 2, a target ring 3, an inorganic colour resolving filter 4, a thin glass plate 5, a transparent signal electrode, such as a Nesa film 6 and a photoelectric converting layer 7. The filter 4, thin glass plate 5, transparent signal electrode 6 and the photoelectric converting layer 7 are stacked and are mounted within the cylindrical tube 2 within which a vacuum is maintained. An electron gun (not shown) within the cylindrical tube 2 generates an electron beam which is controlled by a deflecting and/or focussing coil assembly (not shown) mounted around the cylindrical tube 2, to scan the photoelectric converting layer 7 to produce at the transparent signal electrode 6, a multi-colour video output signal. The above-described structure is substantially the same as that of a conventional image pickup device used in colour TV cameras but, in addition, the device of Fig. 1 comprises, an optical block PB having an absorption type filter A which removes light at near-infrared wavelengths. The filter A, which is referred to as a near-infrared absorption filter (or simply as an IR filter hereafter) is adhered to the front surface of the face plate 1 so as to intervene between the face plate 1 and the lens system 8. In the above, "front" is intended to mean that side closer to a subject to be observed, and "rear" indicates that side which is closer to the photoelectric converting layer 7. The IR filter A is made of a coloured glass produced by adding phosphoric acid and copper oxide to a glass material. For instance, a coloured glass C–500 manufactured by Hoya Glass Co., may be used. Since the spectral characteristic of the IR filter A determines the upper transmittance wavelength limit of a reproduced signal R, the half-width of the IR filter A is designed so that a half value of the signal R is at approximately 638 nm as shown in Fig. 2. In this embodiment, the half-width of the IR filter A is set to approximately 610 nm so as to obtain a desired spectral sensitivity for the signal R. The IR filter A is secured to the surface of the face plate 2 by means of a transparent adhesive including a glass-like material.

Although optical elements are usually coated with a reflection-proof layer, such a layer is not applied to the front surface of the optical block PB used in the present invention. As a result, the transmittance of the optical block PB is approximately 95 percent. If such a reflection-proof layer were applied to the front surface of the optical block PB, light rays reflected at the taking lens 8 would be transmitted through the optical block PB. However, since such a layer is not provided most of such undesirable reflected light from the taking lens 8 is effectively reflected at the front surface of the optical block PB.

The colour-resolving filter 4 may be a colour-resolving striped filter such as disclosed in United States Patent 4,041,528 and, further, may be made by vapour deposition on the rear surface of the transparent face plate 1.

Figs. 3 and 4 illustrate second and third embodiments in which a crystal filter B is used in addition to the IR filter A of the first embodiment so that the optical block PB includes the near-infrared filter A and the crystal filter B. In the second embodiment (Fig. 3), the crystal filter B is placed in front of the IR filter A which is secured to the face plate 1, and in the third embodiment (Fig. 4), the crystal filter B is secured to the face plate 1 and the IR filter A is placed in front of the crystal filter B. In both cases the IR filter A and the crystal filter B are laminated and adhered to each other by way of a suitable transparent adhesive. The crystal filter B functions as an optical low pass filter which is usually needed in the optical system of a colour TV camera of the type using a colour-resolving striped filter.

Fig. 5 illustrates a fourth embodiment in which the optical block PB comprises a single IR filter A, two crystal filters B and C and a quarter-wave plate D. The quarter-wave plate D and the IR filter A are laminated and the lamination thereof is interposed between the two crystal filters B and C. Since a fundamental wave and a second harmonic wave are used to reproduce colours in an image pickup device using a colour-resolving striped filter, the two low pass filters, i.e. the crystal filters B and C, and the quarter-wave plate D are used to block two wavelengths.

In the above-described embodiments, it is to be noted that the IR filter A is interposed between two optical elements and in the second and fourth embodiments (Figs. 3 and 5) both surfaces of the IR filter A are directly connected to the adjacent optical elements. Consequently, both surfaces of the IR filter A are covered, with advantage of making the IR filter A moisture-proof avoiding the formation thereon, due to ambient moisture of white clouds, so increasing the useful life of the IR filter A.

Although crystal filter(s) is/are used used in the above embodiments of Figs. 3 to 5, diffraction grating filter(s) may also be used as (a) low pass filter(s) if desired.

As described above, the IR filter A disposed in the optical path between the lens system 8 and the face plate 1, effects significant attenuation (by absorption) of near-infrared light before light rays from a subject are applied to the colour-resolving filter 4. Therefore, with an organic colour-resolving filter 4 light reflected by the filter toward the face plate 1 and the optical block PB, where the reflected light includes light at wavelengths other than those transmitted through

the optical block PB, has less near-infrared light inasmuch as the wavelength of reflected light is limited to a range (see hatched portion in Fig. 6) enclosed by the upper transmittance wavelength limit of the green filter and the cyan filter both includes in the colour-resolving filter 4, and by the near-infrared filter spectral characteristic.

Furthermore, because near-infrared light reflected at the colour-resolving filter 4 is attenuated by the IR filter A when the reflected light rays propogate through the near infrared absorption filter A after passing through the face plate 1, the near-infrared component of the reflected light further reflected at the lens system 8 or the front surface of the optical block PB, is very small. Within the light reflected at the colour separation filter 4, light at wavelengths shorter than the near-infrared wavelengths is also attenuated upon passing through or reflection by optical elements, so that the amount of light reflected at the colour-resolving inorganic filter 4 greatly reduced.

As described above, although light returned to the lens system 8 through the front surface of the optical block PB is again reflected at the lens system for transmission to the optical block PB, some of the light incident on the optical block PB is reflected at the front surface of the optical block PB. Furthermore, although light not reflected at the front surface of the IR filter A may be applied to the photoelectric converting layer 7 through the face plate 1, the near-infrared component thereof is attenuated before reaching the photoelectric converting layer 7 since such light necessarily passes through the IR filter A.

Also, since the optical block PB is adhered to the front surface of the transparent face plate 1, any light whether passing for the first time through the lens system 8 or following one or more reflections within the optical system, reflected at the colour-resolving filter 4 onto the face plate 1 is not reflected at the front surface of the face plate 1; i.e. light reflected at the colour-resolving filter 4 propogate through the face plate 1 and the optical block PB. Some of the light returned to the optical block PB from the colour-resolving filter 4, and having an angle of incidence (with respect to the plane of the colour-resolving filter 4) greater than a predetermined value, is directed to the periphery of the optical block PB as shown in Fig. 7 (see solid line). Furthermore, some light from the colour-resolving filter 4 is reflected at the front surface of the optical block PB, and if the angle of incidence (with respect to the colour-resolving filter 4) is greater than a predetermined value such twice-reflected light is also directed to the periphery of the optical block PB as indicated (see dotted line). Light incident on the periphery of the optical block PB is greatly absorbed and therefore attenuated. In other words, light may be partially reflected at the periphery of the optical block PB to be again applied to the colour-resolving filter 4 through the face plate 1 with the intensity being attenuated. There is, therefore, little chance that such light reflected at the periphery of the optical block PB will be applied to the photoelectric converting layer 7. From the above it will be understood that, even though light reflected by the colour-resolving filter 4 may be further reflected toward the colour-resolving filter 4, the amount of such reflected light applied to the photoelectric converting layer 7 is very small, so that the photoelectric converting layer 7 produces an output video signal capable of reproducing images with hardly any flares. In Fig. 7 and 8 hatching (indicating a cross-section) is omitted from the optical block PB and the transparent face plate 1 for simplicity.

Reference is now made to Fig. 8 showing a fifth embodiment of the present invention, in which light propogating within the optical block PB toward the periphery thereof is effectively absorbed by way of a black body 9 provided around the periphery of the optical block PB. Such a black body 9 may comprise a black paint, such as Indian ink, black lacquer or the like, or a black film.

Since most of the light incident on the periphery of the optical black PB is absorbed, an even greater reduction in amount of undesirable light reflected toward the photoelectric converting layer 7 is achieved. Although the fifth embodiment of Fig. 8 is illustrated as an improvement of the second embodiment of Fig. 3, the combination of an optical block PB and a black body 9 may also be applied to any of the embodiments of the present invention.

In tests using an image pickup device as described above with reference to Fig. 5. to reproduce on a CRT a picture of a candle flame, undesirable flare was attenuated by approximately 10 dB. The thickness of each of the optical elements of the optical block PB and the effective scanning area of the photoelectric converting layer 7 were as follows:

Thickness of IR Filter A	1.6 mm
Thickness of Quarter-wave plate D	0.5 mm
Thickness of Crystal filter B	3.264 mm
Thickness of crystal filter C	1.632 mm
Effective scanning area	8.8 mm by 6.6 mm

Although the above-embodiments are all single tube image pickup devices, it is apparent that the present invention is also applicable to a single-plate colour TV image pickup device using a solid image sensor.

CLAIMS

1. Apparatus for generating colour TV signals comprising lens means; photoelectric converter having a transparent face plate, a colour-resolving striped filter, and a colour TV imager responsive to light applied thereto from the lens means via the face plate and the colour-resolving filter for producing a colour video signal; and an optical block having a near-infrared absorption filter, the optical block being disposed between the lens means and the face plate with one surface thereof adhered to a surface of the face plate.

2. Apparatus according to claim 1, wherein the optical block also comprises a crystal filter adhered to the near-infrared absorption filter.

3. Apparatus according to claim 2, wherein the near-infrared absorption filter is adhered to the face plate so as to be sandwiched between the face plate and the crystal filter.

4. Apparatus according to claim 1, wherein the optical block has a transmittance which is approximately 95 percent.

5. Apparatus according to claim 1, wherein the optical block also comprises first and second crystal filters and a quarter-wave plate adhered to the near-infrared absorption filter to form a laminate, the laminate being sandwiched between the first and second crystal filters.

6. Apparatus according to any one of claims 1 to 5 further comprising a black body around the periphery of the optical block.

7. Apparatus for generating colour television signals constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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